Electric Snowmobile Demonstration Status Report

SnoLectric
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Introduction

Snowlectric has been engaged in a cooperative agreement with the National Parks Service/ Yellowstone (NPS) for the past 18 months to explore the possibilities of an electric snow machine. NPS supplied Snowlectric with a Polaris Indy 500 snowmobile chassis, and this machine has successfully been converted to a fully electric-powered snowmobile. Snowlectric supplied all of the necessary operating components and labor. This report summarizes prototype testing and drive analysis.

Power Systems and Performance

Testing was performed at 48, 72, and 120 volts (V), as increased voltage requires less current to generate the same power. Since high current drain is one of the primary factors in reduced battery, motor and controller life, it was expected that higher system voltages should allow more power to be successfully drawn from the batteries. These concepts proved themselves, as progressions to higher voltage yielded both increased power and longer runs.

Most of the testing was at 72 V, which yielded a typical run of about 5 miles at 25 mph. A top speed of 55 mph was achieved on asphalt. Acceleration was similar to a standard snowmobile. Hill performance on slopes of 6-8 percent was 20-30 mph, and 12 mph on a slope of 20 percent. At 120 V, the top speed was 35-40 mph. However, spring arrived before a good database could be developed at 120 V. The data suggests to us that 120 volts or greater will be the best choice for this machine.

Transmission

Two different transmission systems have been tested: a direct drive gear system that uses a poly belt, and a standard snowmobile clutch Continuously Variable Transmission (CVT).

The direct drive system has shown itself to be quieter and more efficient at cruising speed, but has undesirable compromises in gear choices as they relate to acceleration vs. cruising power requirements.

The existing CVT in snowmobiles has many advantages, primarily it's performance at a variety of speeds. The standard clutch was modified to operate within the general RPM range of the electric motor, but was not optimized, as the primary clutch will only close about half of what it should. The optimum combination of heavier weights and lighter springs, as well as the proper chain case ratio, should correctly tune the CVT to the range of electric motor operation, thus providing a noticeable increase in efficiency and top speed.

Limitations

One major problem with the current prototype is that it weighs about 900 pounds at 72 V. The recharge time is 4-5 hours. Furthermore, the combination of cold temperature and high discharge rate is a dual blow to the suitability and life of lead acid batteries.

Emissions

Zero.

Noise

As expected, this machine exhibits a huge advantage over conventional 2-stroke snowmobiles in the area of noise reduction. The data in the following table was collected under the severest possible conditions; a crusty, frozen snowmobile track with solid frozen surrounding snow. All data was collected at full throttle using the "A" scale weighting on the decibel meter. Distance was measured perpendicular to the path of the snowmobile for both (CVT and direct drive) types of transmissions.

Distance to Snowmobile (ft)	CVT noise dB	Direct drive noise dB
50	69	66
100	61	61
150	58	54

(In contrast, casual readings taken on 2-stroke snowmobiles in West Yellowstone registered from 80-85 decibels at 50 feet.)

There is also a noticeable difference in the nature of the noise created by an electric motor vs. a 2-stroke gasoline engine. The noise created by a 2-stroke engine is of a much higher frequency, which propagates through air better than lower frequencies. Electric motors are virtually silent. The majority of the noise that is created by the electric snowmobile is the inherent low frequency mechanical vibration created by the transmission, track, suspension, and skis. These low frequency noises are quickly dampened by the surrounding snow, and partially explain the rapid drop in noise level with decreasing distance observed in the above figure. Packed powder or light snow conditions should yield significantly quieter readings.

Summary and Proposal

The intent of this project was to demonstrate an electric snowmobile that used a standard motor and energy supply, and to collect baseline data to prove concept viability. All testing to this point has been executed using standard electric vehicle (EV) technology, transmissions modified with standard parts, and lead-acid batteries. Appropriate technologies for a motor and transmission have been identified, but lead acid batteries are not a good choice due to their poor cold weather discharge, low capacity performance, heavy weight, and relatively meager energy density. The next planned battery step was to upgrade to Nickel Metal-Hydride (NiMh) batteries, which have improved cold weather performance, lighter weight, and improved capacity. The advanced step was to explore the use of fuel cells, which are the most attractive option. Fortunately, fuel cell technology has increased much faster than anticipated, and small vehicle transportation fuel cells are now reportedly available for prototype demonstration. This exciting information leads the scope of the project past

NiMh batteries and directly to fuel cells. Fuel cells provide much higher energy density, immediate refill, longer range, and greatly decreased weight. It is anticipated that a 20 Kilowatt fuel cell and electric motor package installed on a standard snowmobile chassis could yield a finished machine weight under 500 pounds, with an expected range of 25-50 miles with speed and performance similar to current trail snowmobiles.

Proposed Objectives

1. A consortium of NPS, DEQ/EPA, DOE, DOD and fuel cell manufacturers should combine their resources to install fuel cells on either a conversion model snowmobile or “ground-up” prototype. The cold temperature, high drain conditions under which a snowmobile operates will provide an excellent testing platform to demonstrate the superior operating capabilities of a fuel cell. Snowlectric is offering to be the organizer and coordinator of such a consortium.
2. Rebuild the current snowmobile chassis to 120 volts lead acid system with and on-board charger and current converters. This option is simply a short term, economical solution that would continue to provide electric snowmobile performance data.